

ADVANCING SURVEILLANCE TEST TECHNOLOGIES



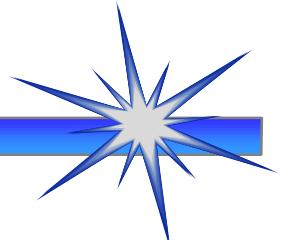
***CENTER FOR APPLIED ANALYTICAL TECHNOLOGIES TEST
& EVALUATION DEPT.
NSWC INDIAN HEAD DIVISION***

***COMNAVSURFWARCCENDIV INDIAN HEAD MD / APPLIED ANALYTICAL LAB
GAIL STINE DIRECTOR (301) 743-6521 GAIL STINE@MAIL.IH.NAVY.MIL***

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OUTLINE ISSUES

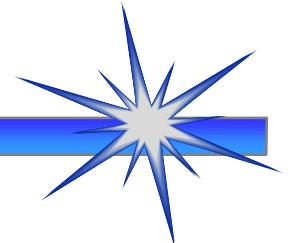
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- Background
- Current Surveillance Test Methods
- Solutions - The New Technologies
 - MEMS
 - Chemical Sensors
 - Embedded Sensors
 - Field Monitoring Miniaturized Instrumentation
- Challenges
- Progress to date
- Summary

BACKGROUND / ISSUES

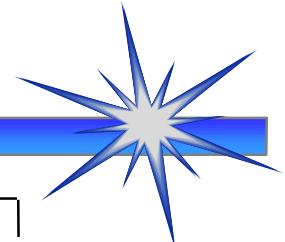
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- Safety - stability concerns
- Inventory control - throughout life cycle
- Performance/Reliability
- Service life predictions/extensions
- Waste management/Demil - Munitions Rule
- Full Life Cycle Management - O/S Cost Reduction

SURVEILLANCE TEST METHODS

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Thermal Stability Testing

- Oven Fume Test
- Differential Scanning Calorimeter (DSC)
- Accelerating Rate Calorimeter (ARC)
- Differential Thermal Analysis (DTA)
- Thermo-gravimetric Analysis (TGA) Taliani
- Vacuum Thermal Stability
- Microcalorimetry
- Thermal cook-off

Stabilizer Determination

- High Performance Liquid Chromatography
- Other Chromatographic methods (GCMS, LCMS, photodiode array)
- Capillary Electrophoresis
- Wet chemistry (Titration techniques)
- Supercritical fluid extraction & chromatography
- Robotics

Other Tests

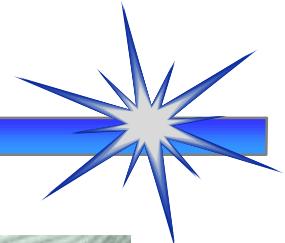
- Mechanical Properties
- Rocket motor performance
- Hybrid Tests (Aging + Stabilizer test)
- Gas analysis (FTIR, CG, etc.)
- Accelerated Aging Tests
- Chemical Migration Tests
- **Fiber optic/Spectroscopy**
- Chemical reactivity/compatibility
- **MEMS/Chemical Sensor**
- **Embedded Sensor**
- **Field monitoring MEMS Instrumentation**

Modeling & Simulation

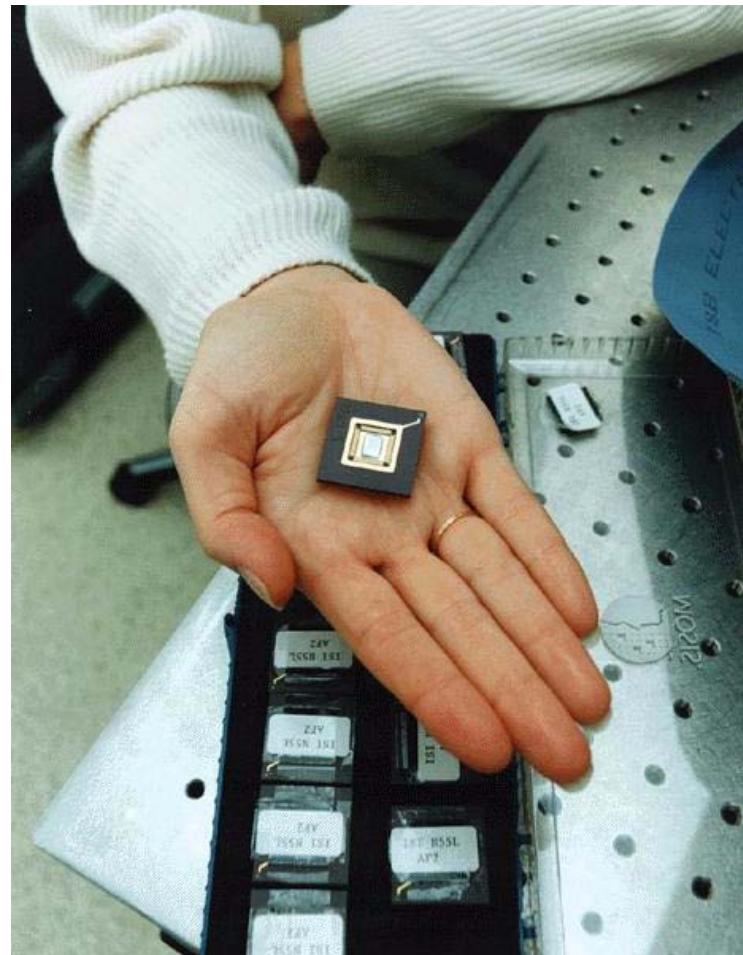
- **Service life prediction**
- Type life
- **Shelf life prediction**
- Kinetic analysis

SOLUTIONS - THE NEW TECHNOLOGIES

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- MEMS
- Chemical sensors
- Embedded sensors
- Fiber optics
- Field monitoring - miniaturized instrumentation

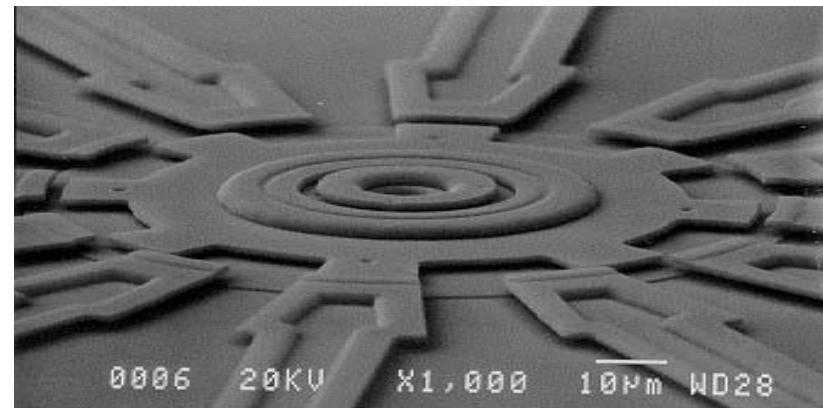
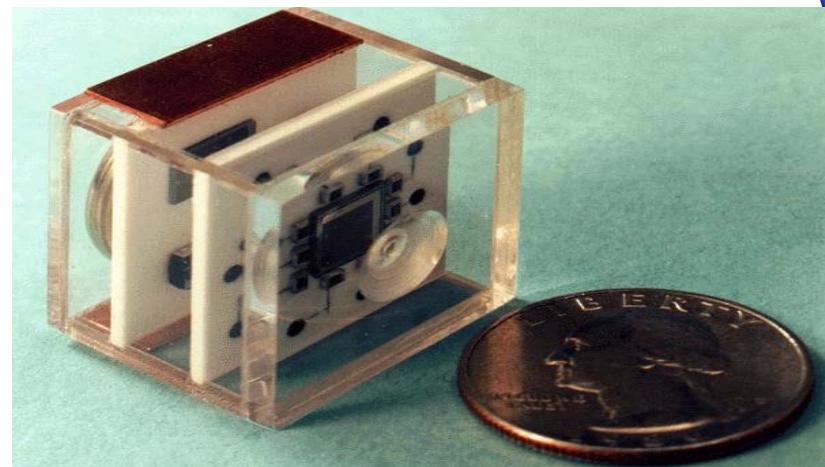


MEMS: MICRO - ELECTRO - MECHANICAL SYSTEMS

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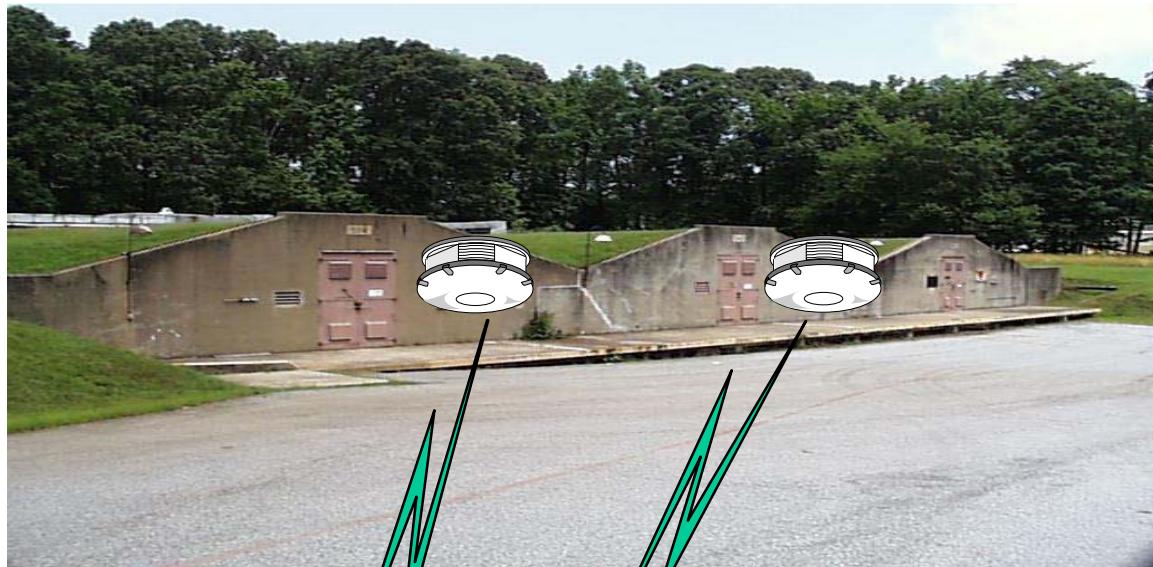
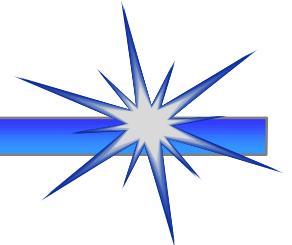


- Miniaturization plus multiple components plus microelectronics
- All components on a chip, dimensions measured in microns
- Uses and applications only limited by the imagination



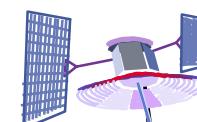
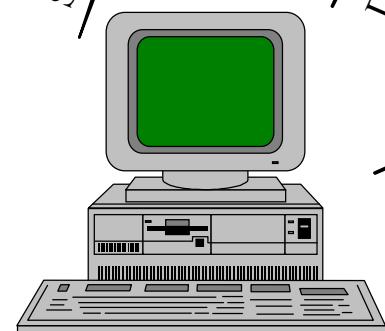
MEMS INVENTORY MANAGEMENT SYSTEM

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Query
Signal

Data
Response



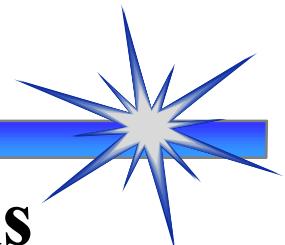
Satellite

Data:
Inventory
Temperature
Chemical
etc.

FLEET
IMSD
etc.

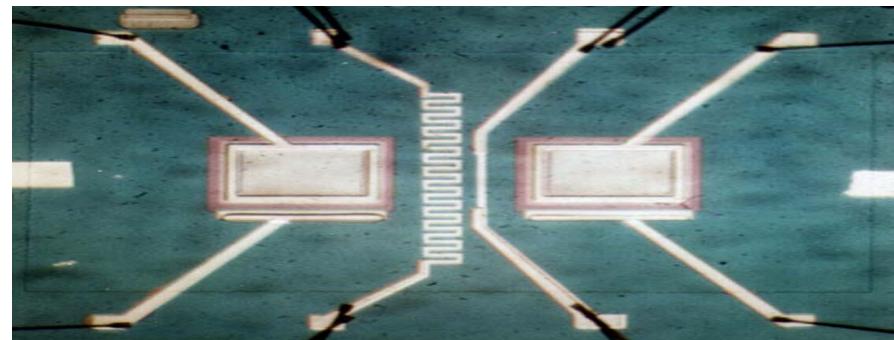
CHEMICAL SENSORS

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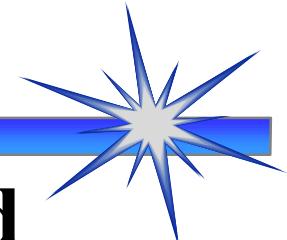
“IN SITU” Real Time Propellant Analysis

- Current technology: electro-chemical cells
- Future technology: molecular imprinted biosensors
 - add sensors serially to MEMS chips
 - potential for embedded applications
 - highly selective for chemical species, i.e., CO Vs CO_2 *Vs NO Vs NO_x , etc.



NO_x SENSOR CHIP

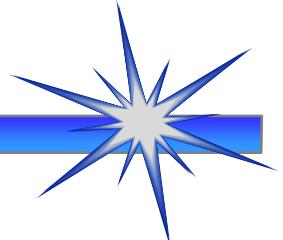
FIELD MONITORING MINIATURIZED INSTRUMENTATION



Bringing Surveillance to the Field

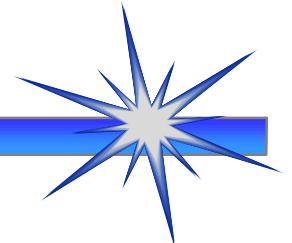
- Research → applications stage
 - UV, FTIR, NIR spectroscopy
 - Mass spectrometry
 - Chromatographic system (HPLC, IC)
 - Capillary zone electrophoresis
 - Fiber optic / spectroscopy
- Advantages :
 - > Reduces/eliminates shipping costs/transportation costs
 - > Non destructive / Non invasive
 - > Enhanced Safety
 - > Operational personnel may be able to perform
 - > Immediate results
 - > Cost reductions allow greater sample size (statistical validation)

CHALLENGES

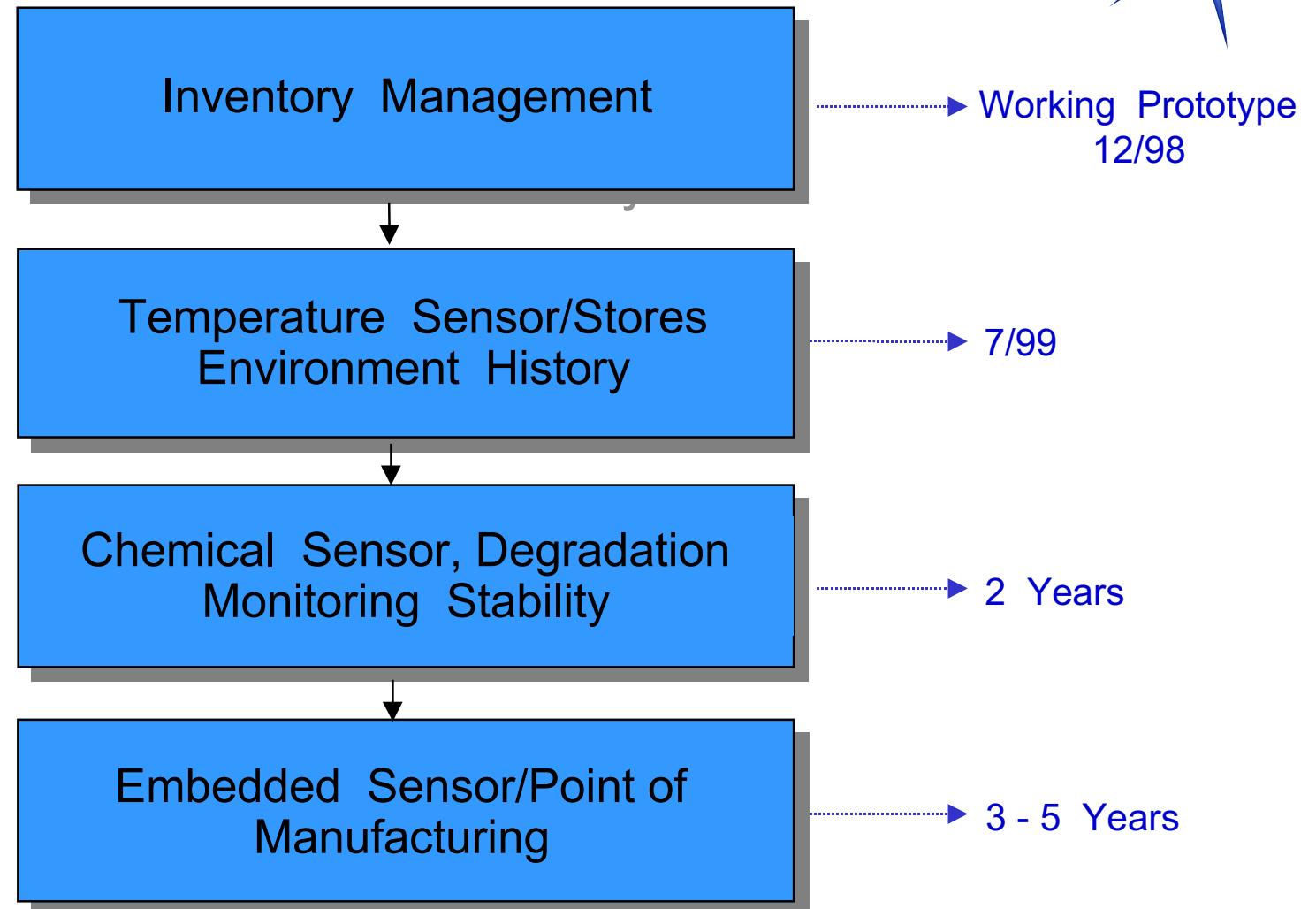


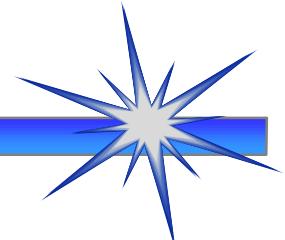
- More Engineering than R&D
 - Power issue
- Integration of sensors to MEMS devices
- Hazards (HERO, physical presence, RF interference, etc)
- Integration into weapon (mft & logistic issues)
- Correlation of chemical sensor data to safe shelf-life
- Pace of Technology advances

CHALLENGES (Cont)



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PROGRESS TO DATE

- Predictive Technology Symposium - Nov 97
 - ARDEC & NSWCIHDIV co-host follow-on workshops Dec 97/May 98
- Surveillance & Predictive Technology Program established at NSWCIHDIV (Jan 98)
- Briefings given:

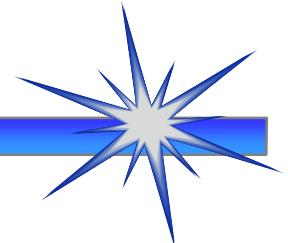
OSD
CINCLANTFLT
CINCPACFLT
NAVSEA
O/EDCA
OPNAV (N4)

ARDEC
DDESB
NSWC
MARCORSYSCOM
NAVORDCEN
MCPD FALLBROOK

NAVSUPSYSCOM
NAWC CHINA LAKE
PACIFIC NORTHWEST
NATIONAL LAB
SECNAV

PROGRESS TO DATE (CONT)

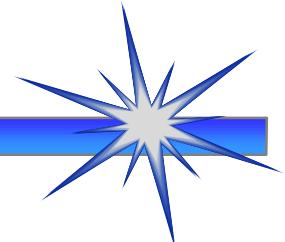
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- Prototype development
 - ✓ Inventory MEMS by 1st qtr FY99
 - ✓ Sensors (Temperature) by 3rd qtr FY99
- Proposals
 - ✓ Navy AIT
 - ✓ PMS 422
 - ✓ PM Crusader
 - ✓ Naval Explosives and Weapon System Safety Program
 - ✓ CNO N86/N88 RDT&E for QE Application

PROGRESS TO DATE (CONT)

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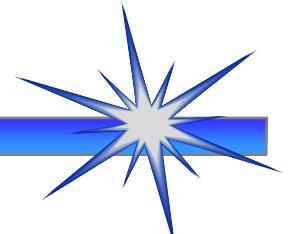


Crusader Program

- Propelling Charge Identification
- Temperature Sensor
- Integration with Fire Control Computer

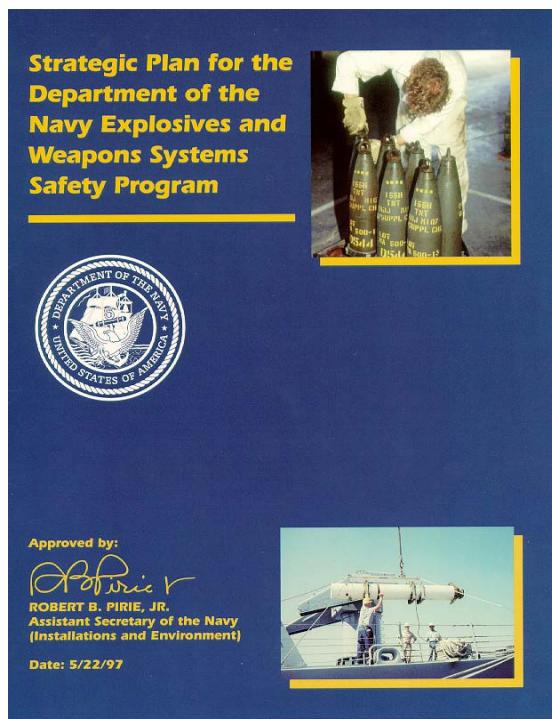


PROGRESS TO DATE (CONT)



DON Explosives & Weapons System Safety Program

- 1997 Plan will advance explosives safety through six strategies
 - Strategy #3 Technology



NSWCIHDIV has submitted six proposals:

- MEMS applications for real time monitoring
- MEMS sensor prototyping with communication media
- MEMS as Safe & Arm devices
- Field monitoring with miniature analytical instruments
- Computer modeling of safety characteristics
- Correlation studies for future tests

PROGRESS TO DATE (CONT)

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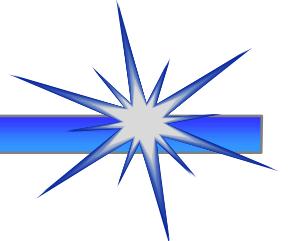


PMS 422 Seatask (Temperature Data Logging)



- Temperature data logging
- Chemical aging analysis and modeling

SUMMARY



- Sensor Technology progressing rapidly
 - applications limited mainly to imagination
- MEMS/Sensors major thrust at NSWCIHDIV
- Interest building Navywide
- Leveraging / teaming essential